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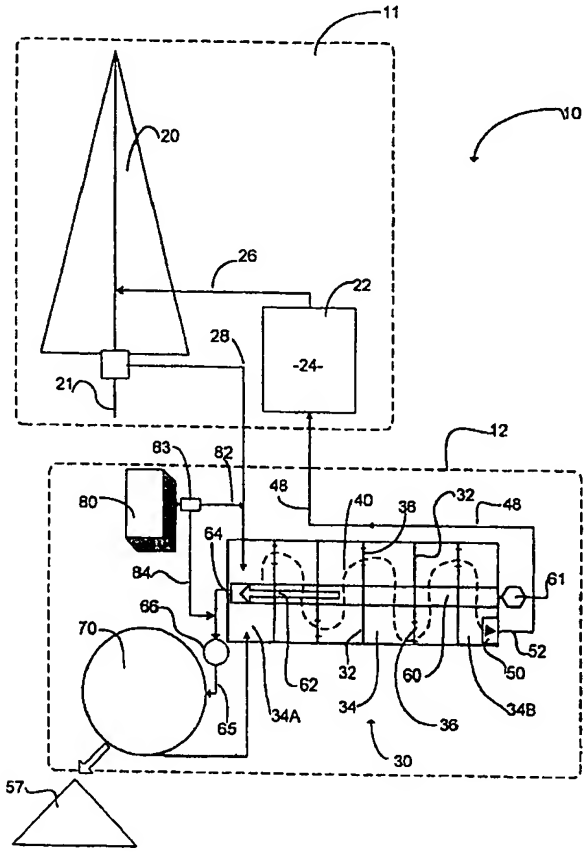

(57) Abrégé/Abstract:
A solids separation system may be used to separate solids, such as cuttings from drilling fluids used in well drilling operations. The system includes a settling tank having transverse baffles defining a fluid receiving chamber, a fluid output chamber and one or more intermediate chambers. Fluid introduced into the fluid receiving chamber can flow in a sinuous path through apertures in

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(57) Abrégé(suite)/Abstract(continued):
the baffles to the fluid output chamber. Solids settle to the bottom of the settling tank. A material conveyor, preferably an auger, extends along a bottom surface of the settling tank to an outlet port in the fluid receiving chamber. A centrifuge is connected to the output port to receive fluid in which solids have been concentrated. Fluid output from the centrifuge is reintroduced into the settling tank. The apparatus and method of the invention permit a single centrifuge to be used to handle a higher volume of fluid than is possible with conventional methods and apparatus. This provides significant cost savings.

Abstract of the Disclosure

A solids separation system may be used to separate solids, such as cuttings from drilling fluids used in well drilling operations. The system includes a settling tank having transverse baffles defining a fluid receiving chamber, a fluid output chamber and one or more intermediate chambers. Fluid introduced into the fluid receiving chamber can flow in a sinuous path through apertures in the baffles to the fluid output chamber. Solids settle to the bottom of the settling tank. A material conveyor, preferably an auger, extends along a bottom surface of the settling tank to an outlet port in the fluid receiving chamber. A centrifuge is connected to the output port to receive fluid in which solids have been concentrated. Fluid output from the centrifuge is reintroduced into the settling tank. The apparatus and method of the invention permit a single centrifuge to be used to handle a higher volume of fluid than is possible with conventional methods and apparatus. This provides significant cost savings.

APPARATUS AND METHOD FOR SEPARATING SOLIDS FROM DRILLING FLUIDS

Technical Field

This invention relates to separators for removing solids from fluids. The methods and apparatus of the invention have particular application in removing solids from drilling fluids used in well drilling operations.

Background

Wells for recovering oil, gas and the like are typically drilled by a drilling rig which includes a hollow drill string with a bit at its lower end. As the drill string is rotated, drilling fluids are pumped down through a channel in the drill string. The drilling fluids pass through the bit and return to the surface on the outside of the drill string. The fluids carry cuttings from the drilling operation to the surface. The drilling fluids are recovered at the surface and then recycled. Water may be used as drilling fluid in shallow drilling. In deeper wells the drilling fluids are denser drilling muds of various compositions as is known to those skilled at drilling wells.

Various apparatus and methods are known for removing cuttings and other undesired solids from drilling fluids so that the drilling fluids may be reused. A widely used method for removing solids from drilling fluid is to pass the recovered drilling fluid through a centrifuge. The centrifuge separates the undesirable solids from the drilling fluid. The drilling fluid output from the centrifuge may then be reused. Because of the volume of drilling fluid used in a typical well drilling operation, it is

necessary to either have a very large centrifuge system or to provide multiple centrifuges. The costs of having a centrifuge system on site and operating the centrifuge system are significant. There is a need for a solids separation system capable of removing solids from drilling fluids which can be provided and operated at reduced cost relative to prior art systems.

Summary of the Invention

It is an object of this invention to provide methods and apparatus for removing solids from drilling fluids which are more cost effective than prior art systems.

One aspect of the invention provides a method for recycling fluid in a drilling operation. The method comprises the steps of: receiving a stream of fluid containing solids; introducing the fluid and a flocculating agent into a settling tank, the tank comprising a plurality of compartments and a material conveyor extending through the compartments in a lower portion of the tank; allowing the fluid to flow along the settling tank in a first direction to a collection area while allowing solids to settle to the bottom of the tank and operating the material conveyor to carry settled solids in a direction toward an output port in the tank, preferably in a second direction opposite to the first direction; withdrawing fluid from the collection area; and, withdrawing a mixture of solids and fluid from the outlet port.

Another aspect of the invention provides apparatus for removing solids from fluids. The apparatus comprises a settling tank and a centrifuge having an inlet in fluid communication with an output port on the settling tank. The settling tank comprises a fluid receiving chamber at a first end of the tank; a fluid output chamber at a second end of the tank; a plurality of transverse apertured baffles extending across the tank between the fluid receiving chamber and the fluid output chamber, the baffles defining one or more intermediate chambers between the fluid receiving chamber and the fluid output chamber; a material conveyor extending along a lower side of the tank to an outlet port at one end of the tank, preferably the first end, the material conveyor comprising a motor driving the material conveyor to carry materials in a direction toward the outlet port; and, a fluid outlet at the second end of the tank.

Brief Description of the Drawings

In drawings which illustrate non-limiting embodiments of the invention:

Figure 1 is a schematic view of a well drilling system incorporating a solids separation apparatus according to the invention;

Figure 2 is a transverse section through a settling tank for use in the invention;

Figure 3 is a longitudinal section through the settling tank of Figure 2; and

Figure 4 is a flow chart illustrating steps in one embodiment of the method of the invention.

Description

Figure 1 is a schematic showing a well drilling system **10** which includes a drill rig **11** and a solids separation system **12** according to the invention. Drill rig **11** includes a tower **20** supporting a drill string **21** which is capable of being driven into the ground by conventional means well known to those skilled in the art. A tank **22** in drill rig **11** contains drilling fluid **24**. The methods of the invention are most effective when drilling fluid **24** is water. However, the invention can also be applied to removing solids from denser drilling muds.

Drilling fluid **24** is pumped through a conduit **26** into drill string **21**. Fluid **24** flows downward through the lower end of drill string **21** where it picks up cuttings from the drilling operation. Fluid **24** flows back to the surface beside drill string **21** carrying the cuttings with it. Fluid **24** is collected when it reaches or nears the surface. The operation of a drill rig **11** using a drilling fluid **24** is well known to those skilled in the art.

Collected fluid **24** passes through conduit **28** to solids separation system **12** which removes solids from fluid **24** and then returns fluid **24** through conduit **48** to tank **22** for reuse.

Solids separation system **12** includes a settling tank **30**. Settling tank **30** has a number of transverse baffles **32** which divide tank **30** into a number of chambers **34**. Chambers **34** may conveniently be made to have the same volumes. Chambers **34** may typically have volumes in the

range of 2,000 liters to 6,000 liters and most typically will have volumes of about 4,000 liters. The invention may be practised with chambers **34** having volumes outside of this range.

Baffles **32** have apertures **36** to permit fluid **24** to flow through tank **30** from an input chamber (or "receiving chamber") **34A** at a first end of tank **30** to an output chamber **34B** at a second end of tank **30** through a number of intermediate chambers **34**. Apertures **36** are staggered on alternating sides of tank **30** so that fluid **24** follows a sinuous path **40** as if flows from input chamber **34A** to output chamber **34B** through intermediate chambers **34**.

A sump **50** is preferably provided in output chamber **34B**. Sump **50** may comprise, for example, a small chamber having a top edge **50A** slightly below the top level of fluid **24** in tank **30**. Fluid **24** flows into sump **50** over top edge **50A**. Fluid **24** is collected in sump **50** and passes through an outlet **52**, which is typically in a side or bottom wall of sump **50**, into a conduit **48** which returns fluid **24** to tank **22** in drilling rig **11** from where it can be reused.

As fluid **24** flows slowly along path **40** through tank **30**, solids suspended in fluid **24** settle to the bottom of tank **30**. A material conveyor extends along the bottom of tank **30**. The material conveyor is preferably an auger **60** driven by a motor **61** so as to move solids in a direction **62** opposite to the flow of fluid **24** along path **40** through tank **30**. Auger **60**

extends to an outlet port **64** at the first end of tank **30**. Auger **60** is preferably generally horizontal.

Suspended solids which fall out of fluid **24** are therefore carried by auger **60** to outlet port **64** against the flow of fluid **24** in tank **30**. Outlet port **64** passes through an end wall of tank **30**. Outlet port **64** is at the opposite end of tank **30** from outlet **52**. Outlet port **64** is preferably below the typical fluid level **F** which is maintained in tank **30** when solids separation system **12** is operating.

The settled solids **57** carried by auger **60** pass through outlet port **64**. Fluid **24** containing the settled solids **57** delivered by auger **60** is carried by a conduit **65** and a pump **66** to a centrifuge **70** which separates solids **57** from fluid **24** and returns cleaned fluid **24** to tank **30**. Centrifuge **70** may be of the type typically used for separating solids from drilling fluids. As described below, the capacity of centrifuge **70** may be significantly lower than would be required if centrifuge **70** were used in a prior art system wherein the entire flow of fluid **24** passes through centrifuge **70**.

The concentration of solids **57** in conduit **65** is significantly greater than the concentration of solids **57** in conduit **28**. Preferably, the cleaned fluid from the fluid output of centrifuge **70** is reintroduced into receiving chamber **34A**.

Most preferably, a flocculating agent or "flocculant", such as a suitable polymerizing material is introduced from a tank **80** through a conduit **82** into conduit **28** before fluid **24** enters tank **30**. As is known in the art, the flocculating agent encourages suspended solids to settle. Polymer tank **80** may conveniently be a separate compartment built into settling tank **30**. Polymer tank **80** should include a mixer (not shown) to keep the flocculating agent stirred. Flocculating agent is also preferably introduced through a conduit **84** into conduit **65** upstream from centrifuge **70**. This aids the centrifugal separation process, as is known in the art. A suitable metering system **83** controls the rate at which flocculating agent is introduced into conduits **28** and **65**.

Solids separating apparatus **12** has the advantage that it concentrates solids **57** before they are provided to centrifuge **70**. The capacity of centrifuge **70** may therefore be much smaller than the capacity that would be required to treat all of fluid **24** coming through conduit **28** in a centrifuge. Typically, only one centrifuge **70** is needed to treat a volume of fluid **24** which would otherwise need two, and perhaps three centrifuges of the same size. This results in a significant reduction in costs to the operator of well drilling system **10**.

Centrifuge **70** should be of a size suited to handle the volume of fluid which is expected to flow through it. A **BRAMATH™** model 1850 centrifuge made by Bramath Ltd. of Calgary, Alberta, Canada has been used successfully as centrifuge **70** in a solids separation system **12**. In some applications in which the invention has been successfully used the flow rate

of fluid **24** and solids **57** through centrifuge **70** is about 300 to 600 liters per minute and the flow rate of dirty fluid **24** entering tank **30** through conduit **28** is in the range of 100 to 2200 liters per minute.Under typical operating conditions the flow rate of fluid **24** through centrifuge **70** is only 25% to 50% of the flow rate of fluid **24** received at solids separation system **12**. Of course, the invention is not limited to these flow rates.

Figure 2 shows a section through tank **30**. As shown in Figure 2, tank **30** preferably has a V-shaped section with auger **60** located in a channel **87** at the bottom of tank **30** between sloping walls **88**. Each of baffles **32** is apertured to allow auger **60** to pass through it. Solids which settle on sloping walls **88** are carried by gravity to auger **60** which carries the settled solids to outlet port **64**. The angle of walls **88** is not critical. Walls **88** should be steep enough to encourage solids **57** which settle on walls **88** to slide down into channel **87**. Solids in channel **87** are moved along by auger **60** to outlet port **64**.

If apparatus **12** is to be operated in a very cold environment then one or more heating elements **90** are preferably provided along side auger **60**. Heating elements **90** may be used to melt any fluids which may freeze around auger **60** if apparatus **12** is left standing long enough for fluid **24** inside tank **30** to freeze around auger **60**. Heating elements **90** may, for example, comprise one or more steam tubes extending longitudinally along an outer surface of tank **30** adjacent auger **60**. The steam tubes may be connected to a source of steam such as a boiler on drill rig **11**.

A prototype settling tank **30** which has been successfully tested and is currently preferred for use in the invention has 7 chambers **34** including fluid receiving chamber **34A** and fluid output chamber **34B**. Each chamber **34** has a surface area of approximately 42 square feet and a volume of approximately 4,000 litres. The rate of flow of fluid **24** through a tank of these dimensions is preferably maintained in the range of 0.1 cubic metres per minute to 2.2 cubic metres per minute for best results. Apertures **36** in the prototype tank **30** comprise rectangular openings 24 inches wide by 10 inches high. In the prototype system, auger **60** is about 9 inches in diameter. The pitch of Auger **60** in the prototype system is about 6 inches.

It is preferable that auger **60** should turn at a fairly slow speed to avoid stirring up sediments from the bottom of tank **30**. Motor **61** may turn auger **60**, for example, at a speed of approximately 10 to 20 rpm.

As shown in Figure 4, the method of the invention begins by providing a solids separating settling tank comprising a material conveyor and a number of transverse baffles (step **100**). A stream of fluid containing solids is then received at the solids separating apparatus (step **102**). The fluid is mixed with a flocculating agent and introduced into a receiving area in the settling tank (step **103**). The fluid and the flocculating agent may be introduced into the tank separately or together.

Next, the fluid is allowed to flow along the settling tank in a first direction to a collection area while solids settle toward the bottom of

the tank (step **104**). Step **104** preferably involves causing the fluid to flow in a sinuous path past baffles in the settling tank. At the same time, the material conveyor is operated to carry settled solids in a direction opposite to the first direction toward an output port in the tank (step **106**). Most preferably, flow through the tank and the operation of the material conveyor both happen continuously. One or both of steps **104** and **106** could be carried out intermittently without departing from the invention.

Finally, cleaned fluids are withdrawn from the collection area (step **108**) and a mixture of fluid and solids is withdrawn from the outlet port (step **110**) and passed through a centrifuge (step **112**) to separate the solids from the fluid. The cleaned fluid from the centrifuge is preferably reintroduced to the settling tank (step **114**), most preferably into the receiving area of the settling tank. Preferably, steps **108** and **110** through **114** are carried out substantially continuously. However, either or both of steps **108** and **110** through **114** may be carried out intermittently without departing from the broad scope of the invention.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. While the invention has been described in conjunction with a conventional drill rig, the invention may be used to remove solids from fluids produced by other drilling systems or to remove solids from fluids which have otherwise become mixed with solids. Construction details such as the slopes of walls **88**, the exact dimensions of chambers **34**, the

volumes of chambers **34** and the dimensions and shapes of apertures **36** may also be varied without departing from the scope of the invention. Other suitable types of material conveyor may be used in place of auger **60**. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

WHAT IS CLAIMED IS:

1. A method for recycling fluid in a drilling operation, the method comprising:

(a) receiving a stream of fluid containing solids;

(b) introducing the fluid and a flocculating agent into a receiving area in a settling tank, the settling tank comprising a plurality of compartments and a material conveyor extending through the compartments in a lower portion of the tank;

(c) allowing the fluid to flow along the settling tank in a first direction from the receiving area to a collection area while allowing solids to settle to the bottom of the tank and operating the material conveyor to carry settled solids in a second direction opposite to the first direction toward an outlet port in the tank;

(d) withdrawing fluids from the collection area;

(e) withdrawing a mixture of solids and fluids from the outlet port; and,

(f) passing the mixture of solids and fluids withdrawn from the output port through a centrifuge to separate fluids from that mixture and introducing the separated fluids into the settling tank.

2. The method of claim 1 wherein introducing separated fluids into the settling tank comprises introducing separated fluids into the receiving area in the settling tank.

3. The method of claim 2 wherein allowing the fluid to flow along the settling tank in a first direction comprises allowing the fluid to flow in a sinuous path through a series of apertures located between adjacent ones of the chambers on alternating sides of the tank.

4. The method of claim 1 wherein the material conveyor comprises an auger and the step of operating the material conveyor to carry settled solids in a second direction comprises rotating the auger.

5. The method of claim 4 wherein the compartments are separated by transverse baffles, the auger extends longitudinally below the baffles and the step of allowing the fluid to flow along the settling tank in a first direction comprises allowing the fluid to flow in a sinuous path through apertures in the baffles while maintaining a fluid level in the settling tank such that an upper surface of the fluid in the settling tank extends through the apertures.

6. The method of claim 1 wherein a flow rate of the mixture of solids and fluids passing through the centrifuge is in the range of 25% to 50% of a flow rate of the received stream of fluid containing solids.

7. Apparatus for removing solids from fluids, the apparatus comprising:

(a) a settling tank comprising:

(i) a fluid receiving chamber at a first end of the tank;

(ii) a fluid output chamber at a second end of the tank;

(iii) a plurality of transverse apertured baffles extending across the tank between the fluid receiving chamber and the fluid output chamber, the baffles defining one or more intermediate chambers between the fluid receiving chamber and the fluid output chamber;

(iv) a material conveyor extending along a lower side of the tank to an outlet port at the first end of the tank, the material conveyor comprising a motor driving the material conveyor to carry materials in a direction toward the outlet port; and,

(v) a fluid outlet at the second end of the tank; and,

(b) a centrifuge having an inlet in fluid communication with the outlet port.

8. The apparatus of claim 7 wherein the material conveyor comprises an auger.

9. The apparatus of claim 8 wherein the settling tank comprises sloping side walls and the auger extends in a channel between the sloping side walls.

10. The apparatus of claim 7 wherein the baffles are apertured on alternating sides of the settling tank, the apertures defining a sinuous fluid flow path through the settling tank.

11. The apparatus of claim 10 wherein the baffles are each penetrated by a rectangular aperture located near an upper edge of the baffle.

12. The apparatus of claim 11 wherein the material conveyor comprises an auger.

13. The apparatus of claim 12 wherein the settling tank comprises sloping side walls and the auger extends in a channel between the sloping side walls.

14. The apparatus of any one of claims 7, 8, 9, 10, 11, 12 and 13 comprising a conduit extending from a fluid output of the centrifuge to the fluid receiving chamber.

15. The apparatus of any one of claims 8, 9, 12, and 13 comprising a heating element extending along the settling tank adjacent the auger.

16. The apparatus of claim 15 wherein the heating element comprises one or more steam tubes connectible to a source of steam.

17. The apparatus of any one of claims 7, 8, 9, 10, 11, 12, 13, 14, 15, and 16 wherein the settling tank has exactly five intermediate chambers between the fluid receiving chamber and the fluid output chamber.

18. The apparatus of any one of claims 7 and 14 wherein the intermediate chambers are substantially equal in volume.

19. The apparatus of any one of claims 7 and 14 wherein the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

20. The apparatus of any one of claims 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 comprising a compartment for holding a flocculating agent and a metering system adapted to deliver flocculating agent from the compartment into the fluid receiving chamber.

21. The apparatus of claim 20 wherein the metering system is adapted to deliver flocculating agent into both the fluid receiving chamber and the centrifuge inlet.

22. The apparatus of claim 7 wherein the output port is located below an operating fluid level in the settling tank.

23. The apparatus of claim 22 wherein the material conveyor extends substantially horizontally.

24. The apparatus of any one of claims 22 and 23 wherein the material conveyor comprises an auger and a motor for rotating the auger.

25. A settling tank for use in removing suspended solids from dirty drilling fluids, the settling tank comprising:

(a) front and rear end walls and left and right sloping side walls defining between themselves an elongated fluid containing region;

(b) a plurality of transverse baffles extending across the tank between the side walls, the baffles defining a fluid receiving chamber at a first end of the tank, a fluid output chamber at a second end of the tank, and at least three intermediate chambers between the fluid receiving chamber and the fluid output chamber;

(c) a sump containing a fluid outlet in the fluid output chamber at the second end of the tank, the sump and fluid outlet defining an upper fluid level;

(d) an aperture in each of the baffles, the apertures positioned on alternating sides of the tank to define a sinuous fluid path between the fluid receiving chamber and the fluid output chamber the apertures located near upper edges of the baffles and having portions extending below the upper fluid level to permit fluid to flow through the tank from the fluid receiving chamber to the fluid output chamber along the sinuous fluid path;

(e) a substantially horizontal auger extending along a lower side of the tank below the baffles to an outlet port at the first end of the tank and below the upper fluid level; and,

(f) a motor driving the auger to carry materials in a direction toward the outlet port.

26. The tank of claim 25 wherein the baffles are substantially vertically oriented.

27. The tank of any one of claims 25 and 26 wherein the apertures are rectangular.

28. The tank of any one of claims 25, 26 and 27 wherein the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

29. The tank of claim 28 wherein the intermediate chambers are substantially equal in volume.

30. A settling tank for use in removing suspended solids from dirty drilling fluids, the settling tank comprising:

(a) front and rear end walls and left and right sloping side walls defining between themselves an elongated fluid containing region;

(b) a plurality of substantially vertically oriented transverse baffles extending across the tank between the side walls, the baffles defining a fluid receiving chamber at a first end of the tank, a fluid output chamber at a second end of the tank, and at least three intermediate chambers between the fluid receiving chamber and the fluid output chamber;

(c) an aperture in each of the baffles, the apertures positioned on alternating sides of the tank near upper edges of the baffles to provide a sinuous fluid path extending through the apertures wherein fluid introduced into the fluid receiving chamber can flow through the tank along the sinuous path from the fluid receiving chamber to the fluid output chamber;

(d) a material conveyor extending along a lower side of the tank below the baffles to an outlet port at the first end of the tank, the output port located below an upper fluid level of the tank; and,

(e) a motor capable of driving the material conveyor to carry materials in a direction toward the outlet port.

31. The tank of claim 30 wherein the material conveyor comprises an auger.

32. The tank of claim 31 wherein, when energized, the motor drives the auger to rotate at a rate in the range of 10 rpm to 20 rpm

33. The tank of claim 30 wherein the apertures are rectangular.

34. The tank of any one of claims 30, 31, 32 and 33 wherein the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

35. The tank of any one of claims 30, 31, 32, 33 and 34 wherein the intermediate chambers are substantially equal in volume.

36. The tank of any one of claims 30, 31, 32, 33, 34, and 35 comprising a compartment for holding a flocculating agent and a metering system for adding flocculating agent from the compartment to a stream of fluid entering the tank.

37. A settling tank for use in removing suspended solids from dirty drilling fluids, the settling tank comprising:

(a) front and rear end walls and left and right sloping side walls

defining between themselves an elongated fluid containing region;

(b) three or more substantially vertically oriented transverse baffles extending across the tank between the side walls;

(c) an aperture in each of the baffles, the apertures positioned on alternating sides of the tank near upper edges of the baffles to provide a sinuous fluid path extending through the apertures wherein fluid introduced at a first end of the tank can flow through the tank along the sinuous path to a second end of the tank;

(d) a material conveyor extending along a lower side of the tank below the baffles and between the sloping side walls, the material conveyor extending to an outlet port at the first end of the tank, the outlet port located below an upper fluid level of the tank;

(e) a motor capable of driving the material conveyor to carry materials in a direction toward the outlet port; and,

(f) a fluid outlet at the second end of the tank for withdrawing fluid which has flowed along the sinuous path.

38. The tank of claim 37 wherein the material conveyor comprises an auger.

39. The tank of claim 38 wherein, when energized, the motor drives the auger to rotate at a rate in the range of 10 rpm to 20 rpm

40. The tank of claim 37 wherein the apertures are rectangular.

41. The tank of any one of claims 37, 38, 39 and 40 wherein a plurality of intermediate chambers are defined between pairs of adjacent ones of the baffles and the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

42. The tank of claim 41 wherein the intermediate chambers are substantially equal in volume.

43. The tank of any one of claims 37, 38, 39, 40, 41 and 42 wherein the fluid outlet is in a sump located at the second end of the tank, the sump comprising an edge over which fluid from the fluid containing region may flow into the sump.

44. The tank of any one of claims 37, 38, 39, 40, 41, 42 and 43 comprising a compartment for holding a flocculating agent and a metering system for adding flocculating agent from the compartment to a stream of fluid entering the tank.

45. A method for recycling fluid in a drilling operation, the method comprising:

(a) receiving a stream of fluid containing solids;

(b) introducing the fluid and a flocculating agent into a receiving area in a settling tank, the settling tank comprising a plurality of compartments and a material conveyor extending through the compartments in a lower portion of the tank;

(c) allowing the fluid to flow along the settling tank in a first

direction from the receiving area to a collection area while allowing solids to settle to the bottom of the tank and operating the material conveyor to carry settled solids toward an outlet port in the tank;

(d) withdrawing fluids from the collection area;

(e) withdrawing a mixture of solids and fluids from the outlet port; and,

(f) passing the mixture of solids and fluids withdrawn from the outlet port through a centrifuge to separate fluids from that mixture and introducing the separated fluids into the settling tank.

46. The method of claim 45 wherein introducing separated fluids into the settling tank comprises introducing separated fluids into the receiving area in the settling tank.

47. The method of claim 46 wherein allowing the fluid to flow along the settling tank in a first direction comprises allowing the fluid to flow in a sinuous path through a series of apertures located between adjacent ones of the chambers on alternating sides of the tank.

48. The method of claim 45 wherein the material conveyor comprises an auger and the step of operating the material conveyor to carry settled solids comprises rotating the auger.

49. The method of claim 48 wherein the compartments are separated by transverse baffles, the auger extends longitudinally below the baffles and the step of allowing the fluid to flow along the settling tank in

a first direction comprises allowing the fluid to flow in a sinuous path through apertures in the baffles while maintaining a fluid level in the settling tank such that an upper surface of the fluid in the settling tank extends through the apertures.

50. The method of claim 45 wherein a flow rate of the mixture of solids and fluids passing through the centrifuge is in the range of 25% to 50% of a flow rate of the received stream of fluid containing solids.

51. Apparatus for removing solids from fluids, the apparatus comprising:

(a) a settling tank comprising:

(i) a fluid receiving chamber at a first end of the tank;

(ii) a fluid output chamber at a second end of the tank;

(iii) a plurality of transverse apertured baffles extending across the tank between the fluid receiving chamber and the fluid output chamber, the baffles defining one or more intermediate chambers between the fluid receiving chamber and the fluid output chamber;

(iv) a material conveyor extending along a lower side of the tank to an outlet port at an end of the tank, the material conveyor comprising a motor driving the material conveyor to carry materials in a direction toward the outlet port; and,

(v) a fluid outlet at the second end of the tank; and,

(b) a centrifuge having an inlet in fluid communication with the outlet port.

52. The apparatus of claim 51 wherein the material conveyor comprises an auger.

53. The apparatus of claim 52 wherein the settling tank comprises sloping side walls and the auger extends in a channel between the sloping side walls.

54. The apparatus of claim 51 wherein the baffles are apertured on alternating sides of the settling tank, the apertures defining a sinuous fluid flow path through the settling tank.

55. The apparatus of claim 54 wherein the baffles are each penetrated by a rectangular aperture located near an upper edge of the baffle.

56. The apparatus of claim 55 wherein the material conveyor comprises an auger.

57. The apparatus of claim 56 wherein the settling tank comprises sloping side walls and the auger extends in a channel between the sloping side walls.

58. The apparatus of any one of claims 51, 52, 53, 54, 55, 56 and 57 comprising a conduit extending from a fluid output of the centrifuge to the fluid receiving chamber.

59. The apparatus of any one of claims 52, 53, 56, and 57 comprising a heating element extending along the settling tank adjacent the auger.

60. The apparatus of claim 59 wherein the heating element comprises one or more steam tubes connectible to a source of steam.

61. The apparatus of any one of claims 51, 52, 53, 54, 55, 56, 57, 58, 59 and 60 wherein the settling tank has exactly five intermediate chambers between the fluid receiving chamber and the fluid output chamber.

62. The apparatus of any one of claims 51 and 58 wherein the intermediate chambers are substantially equal in volume.

63. The apparatus of any one of claims 51 and 58 wherein the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

64. The apparatus of any one of claims 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62 and 63 comprising a compartment for holding a flocculating agent and a metering system adapted to deliver flocculating agent from the compartment into the fluid receiving chamber.

65. The apparatus of claim 64 wherein the metering system is

adapted to deliver flocculating agent into both the fluid receiving chamber and the centrifuge inlet.

66. The apparatus of claim 51 wherein the output port is located below an operating fluid level in the settling tank.

67. The apparatus of claim 66 wherein the material conveyor extends substantially horizontally.

68. The apparatus of any one of claims 66 and 67 wherein the material conveyor comprises an auger and a motor for rotating the auger.

69. A settling tank for use in removing suspended solids from dirty drilling fluids, the settling tank comprising:

(a) front and rear end walls and left and right sloping side walls defining between themselves an elongated fluid containing region;

(b) a plurality of transverse baffles extending across the tank between the side walls, the baffles defining a fluid receiving chamber at a first end of the tank, a fluid output chamber at a second end of the tank, and at least three intermediate chambers between the fluid receiving chamber and the fluid output chamber;

(c) a sump containing a fluid outlet in the fluid output chamber at the second end of the tank, the sump and fluid outlet defining an upper fluid level;

(d) an aperture in each of the baffles, the apertures positioned

on alternating sides of the tank to define a sinuous fluid path between the fluid receiving chamber and the fluid output chamber the apertures located near upper edges of the baffles and having portions extending below the upper fluid level to permit fluid to flow through the tank from the fluid receiving chamber to the fluid output chamber along the sinuous fluid path;

(e) a substantially horizontal auger extending along a lower side of the tank below the baffles to an outlet port at an end of the tank and below the upper fluid level; and,

(f) a motor driving the auger to carry materials in a direction toward the outlet port.

70. The tank of claim 69 wherein the baffles are substantially vertically oriented.

71. The tank of any one of claims 69 and 70 wherein the apertures are rectangular.

72. The tank of any one of claims 69, 70 and 71 wherein the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

73. The tank of claim 72 wherein the intermediate chambers are substantially equal in volume.

74. A settling tank for use in removing suspended solids from dirty drilling fluids, the settling tank comprising:

(a) front and rear end walls and left and right sloping side walls defining between themselves an elongated fluid containing region;

(b) a plurality of substantially vertically oriented transverse baffles extending across the tank between the side walls, the baffles defining a fluid receiving chamber at a first end of the tank, a fluid output chamber at a second end of the tank, and at least three intermediate chambers between the fluid receiving chamber and the fluid output chamber;

(c) an aperture in each of the baffles, the apertures positioned on alternating sides of the tank near upper edges of the baffles to provide a sinuous fluid path extending through the apertures wherein fluid introduced into the fluid receiving chamber can flow through the tank along the sinuous path from the fluid receiving chamber to the fluid output chamber;

(d) a material conveyor extending along a lower side of the tank below the baffles to an outlet port at an end of the tank, the output port located below an upper fluid level of the tank; and,

(e) a motor capable of driving the material conveyor to carry materials in a direction toward the outlet port.

75. The tank of claim 74 wherein the material conveyor comprises an auger.

76. The tank of claim 75 wherein, when energized, the motor drives the auger to rotate at a rate in the range of 10 rpm to 20 rpm

77. The tank of claim 74 wherein the apertures are rectangular.

78. The tank of any one of claims 74, 75, 76 and 77 wherein the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

79. The tank of any one of claims 74, 75, 76, 77 and 78 wherein the intermediate chambers are substantially equal in volume.

80. The tank of any one of claims 74, 75, 76, 77, 78 and 79 comprising a compartment for holding a flocculating agent and a metering system for adding flocculating agent from the compartment to a stream of fluid entering the tank.

81. A settling tank for use in removing suspended solids from dirty drilling fluids, the settling tank comprising:

(a) front and rear end walls and left and right sloping side walls defining between themselves an elongated fluid containing region;

(b) three or more substantially vertically oriented transverse baffles extending across the tank between the side walls;

(c) an aperture in each of the baffles, the apertures positioned on alternating sides of the tank near upper edges of the baffles to provide a sinuous fluid path extending through the apertures wherein fluid introduced at a first end of the tank can flow through the tank along the sinuous path to a second end of the tank;

(d) a material conveyor extending along a lower side of the tank

below the baffles and between the sloping side walls, the material conveyor extending to an outlet port at an end of the tank, the outlet port located below an upper fluid level of the tank;

(e) a motor capable of driving the material conveyor to carry materials in a direction toward the outlet port; and,

(f) a fluid outlet at the second end of the tank for withdrawing fluid which has flowed along the sinuous path.

82. The tank of claim 81 wherein the material conveyor comprises an auger.

83. The tank of claim 82 wherein, when energized, the motor drives the auger to rotate at a rate in the range of 10 rpm to 20 rpm

84. The tank of claim 81 wherein the apertures are rectangular.

85. The tank of any one of claims 81, 82, 83 and 84 wherein a plurality of intermediate chambers are defined between pairs of adjacent ones of the baffles and the intermediate chambers each have a volume in the range of 2000 litres to 6000 litres.

86. The tank of claim 85 wherein the intermediate chambers are substantially equal in volume.

87. The tank of any one of claims 81, 82, 83, 84, 85 and 86 wherein the fluid outlet is in a sump located at the second end of the tank,

the sump comprising an edge over which fluid from the fluid containing region may flow into the sump.

88. The tank of any one of claims 81, 82, 83, 84, 85, 86 and 87 comprising a compartment for holding a flocculating agent and a metering system for adding flocculating agent from the compartment to a stream of fluid entering the tank.

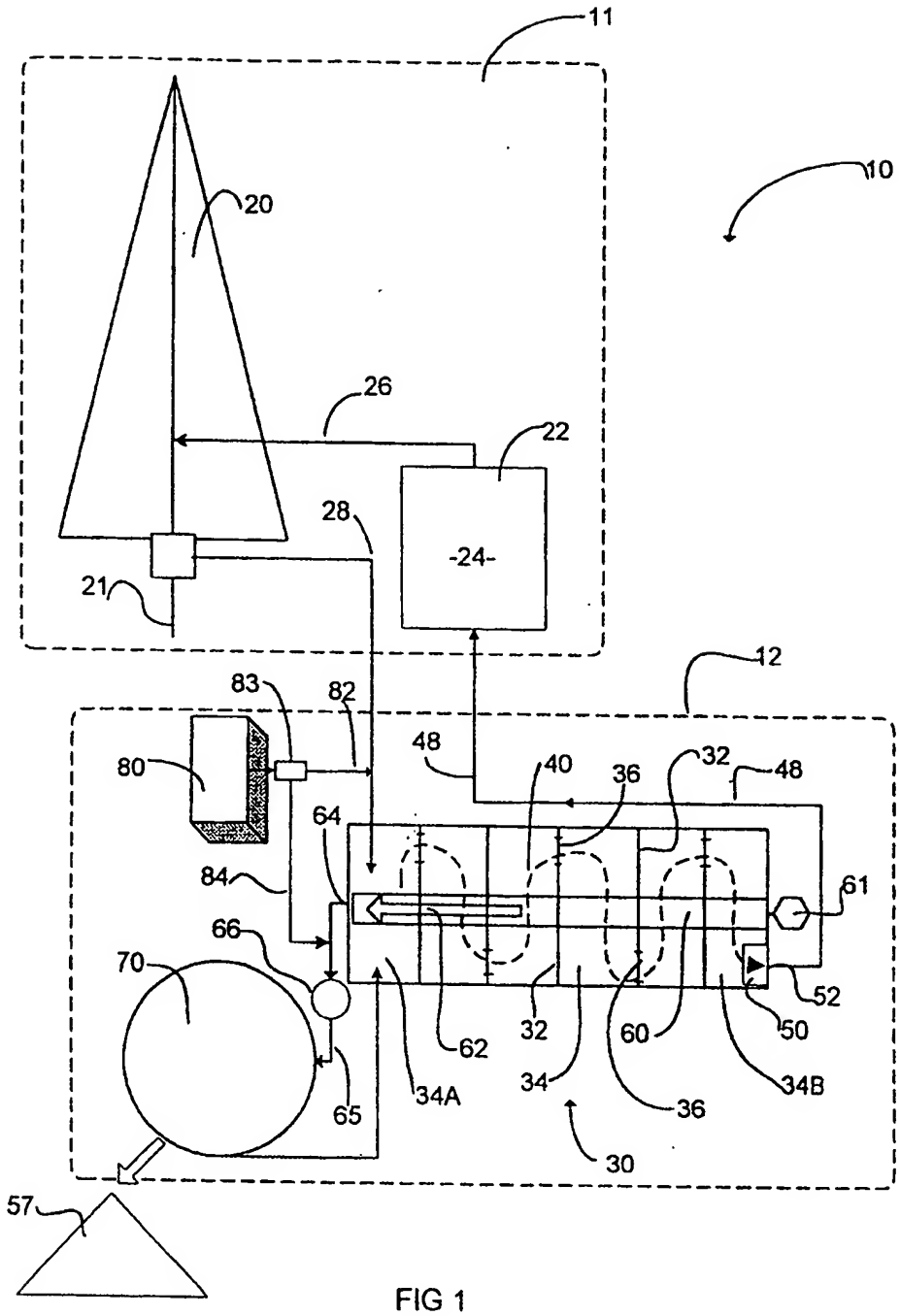
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FIG 1

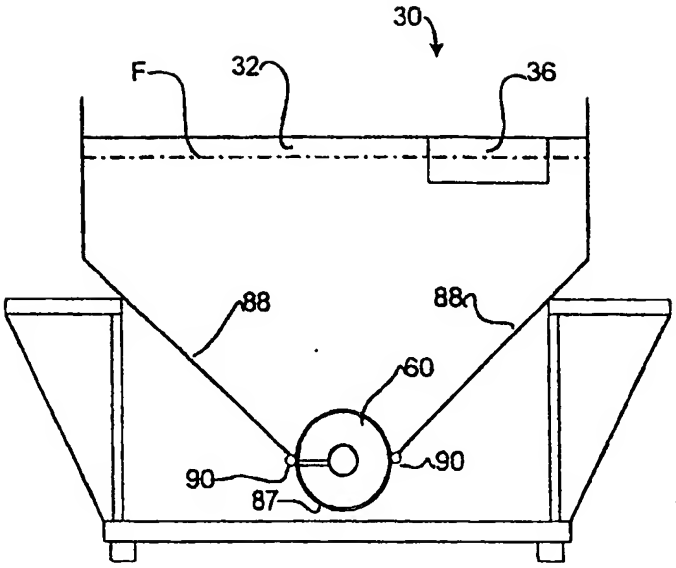

FIG 2

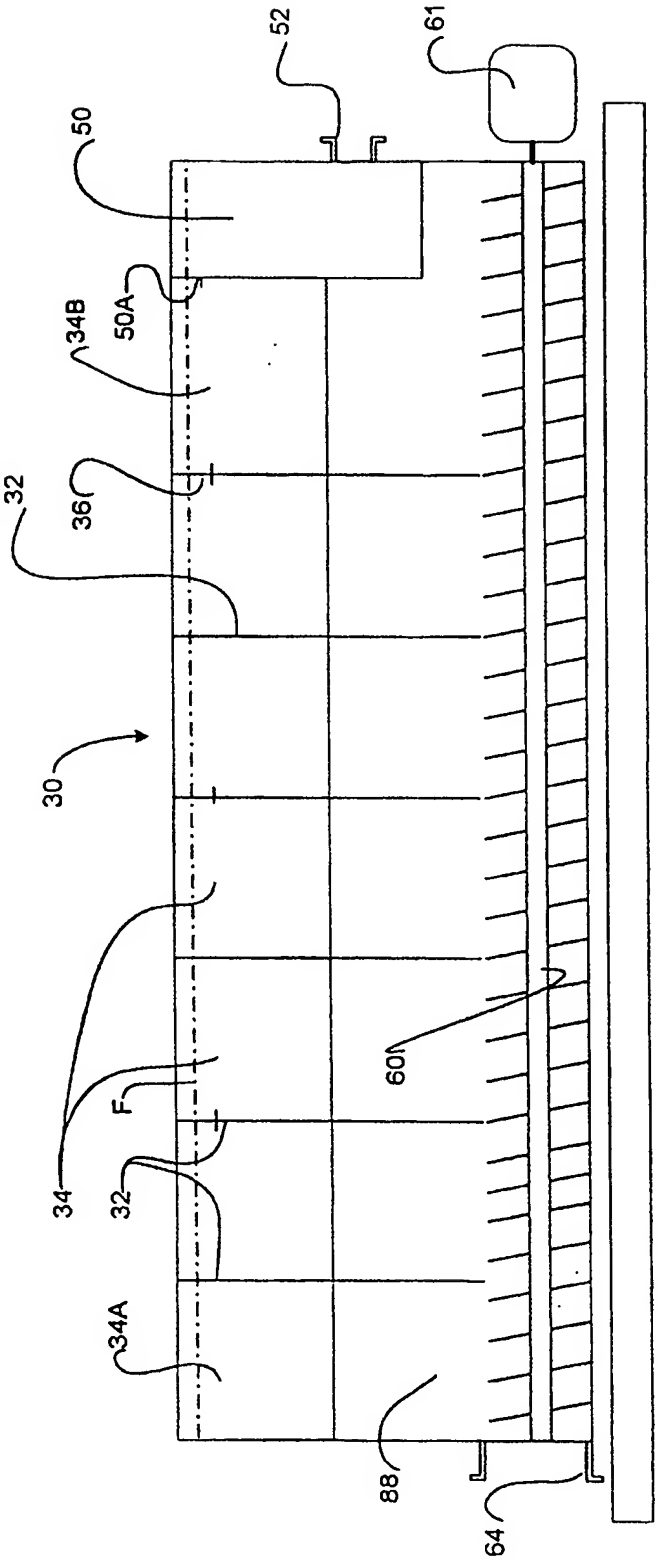

FIG 3

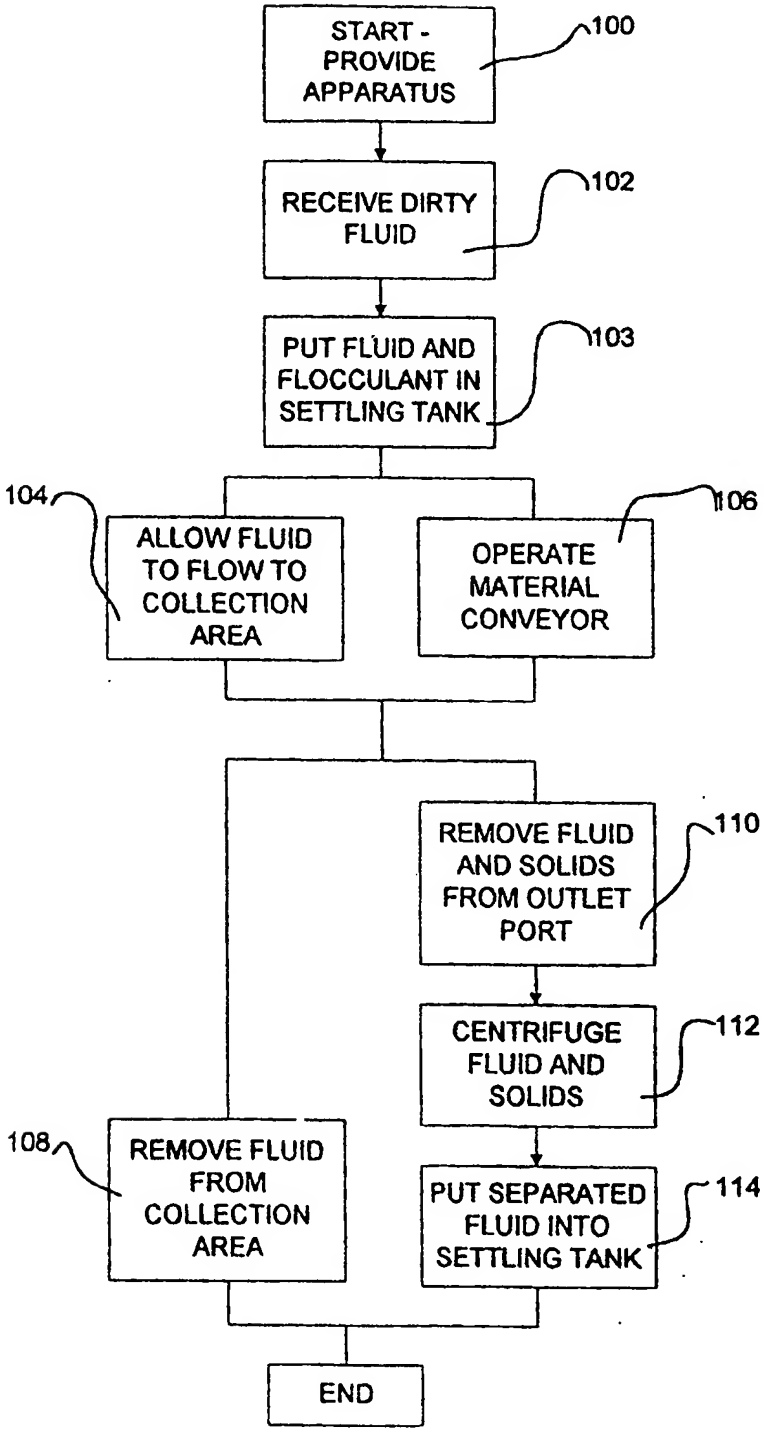
START - PROVIDE APPARATUS
100
RECEIVE DIRTY FLUID
102
PUT FLUID AND FLOCCULANT IN SETTLING TANK
103
104
ALLOW FLUID TO FLOW TO COLLECTION AREA
OPERATE MATERIAL CONVEYOR
106
REMOVE FLUID AND SOLIDS FROM OUTLET PORT
110
CENTRIFUGE FLUID AND SOLIDS
112
108
REMOVE FLUID FROM COLLECTION AREA
PUT SEPARATED FLUID INTO SETTLING TANK
114
END

FIG 4